

**G.E. 120.3**  
**Introduction to Engineering II**

**FINAL EXAMINATION #2**

April 15, 2005  
2:00 PM - 4:00 PM

STUDENT NAME: \_\_\_\_\_

STUDENT NUMBER: \_\_\_\_\_

LECTURE SECTION: ☐ L02    Tu-Th    11:30 – 1:00    Prof. H.C. Wood  
☐ L04    Tu-Th    1:00 – 2:30    Prof. T.A. Fonstad  
☐ L06    Tu-Th    2:30 – 4:00    Prof. D.X.B. Chen

Question 1	/ 15
Question 2	/ 15
Question 3	/ 15
Question 4	/ 15
Question 5	/ 15
Question 6	/ 15
TOTAL	/ 90

**GENERAL INSTRUCTIONS FOR THE QUESTIONS**

- 1) **NO** textbooks, **NO** notes, **NO** assignments, and **NO** laboratory logbooks/reports.
- 2) **NO calculators allowed.**
- 3) Neatness counts. Please ensure your paper is readable.
- 4) Some questions contain special instructions. Please ensure that you read these carefully.
- 5) Not all questions are of the same difficulty and value. Consider this when allocating time for the solution.
- 6) *IF A QUESTION PROVES TO BE TOO HARD FOR YOU TO SOLVE, GO ON TO ANOTHER QUESTION! RETURN TO THE TROUBLESOME QUESTION WHEN TIME PERMITS.*

**PLEASE NOTE**

**ALL parts of the examination paper MUST be handed in before leaving.**  
**Please check that your examination paper contains 9 pages TOTAL.**

QUESTION #1

MARKS: 15 (1+2+2+2+3+2+3)

Discipline Lectures/Labs

1. If it takes a cow and a half a day and a half to have a calf and a half, how much energy would it take a chicken with a wooden leg of 4mm diameter to push the cherry pit out of a 20 mm diameter cherry?
- 
2. In the Civil Engineering lecture they mentioned at least four (4) areas of specialization that a student could pursue. Give two (2) of these areas of specialization.
- a)
- b)
3. In the Civil Engineering lab, why did we have to drill numerous gas extraction wells?
- 
- 
4. List two of the Saskatchewan companies that the Electrical Engineering discipline presentation stated hired electrical engineering graduates.
- a)
- b)
5. From the Agricultural and Bioresource lab, list one (1) constraint and two (2) criteria for the design of the cherry pitting machine.
- Constraint
- Criteria
- 
6. In the Engineering Physics Lab, what was the condition that must be met to ensure a satellite goes into orbit about the earth?
-

QUESTION #1 (continued)

*Logic Problem*

A sack contains three red hats and two blue hats. Three G.E. 120.3 students sit facing forward, one behind the other. The student at the front sees the blackboard, the student in the middle sees the student in the front and the blackboard, and the student at the back sees the middle and the front student and the blackboard. **The students can only look straight ahead (this becomes important below).**

A hat is drawn at random and placed on each student’s head. The student at the back looks at the two students in front (and their hats) and determines (through logic) that s/he knows the color of her/his hat. Based upon the determination s/he says either “I know the color of my hat” or “I don’t know the color of my hat”. **The student cannot (does not) look at the hat on her/his own head.**

Based upon what the student at the back says (and through logic) the student in the middle does the same while looking at the student in front (at their hat). Based upon the determination s/he says either “I know the color of my hat” or “I don’t know the color of my hat”. **The student cannot (does not) look at the hat on her/his own head.**

Based upon what the first two students say (and through logic) the student at the front does the same. Based upon the determination s/he says either “I know the color of my hat” or “I don’t know the color of my hat”. **The student cannot (does not) look at the hat on her/his own head.**

Under what conditions, if any, can the student at the front say, “I know the color of my hat”?

**QUESTION #2****MARKS: 15 (5+5+5) (Show your work)**

1.0 Given:

$$\mathbf{u} = [2 \ -3 \ 1], \quad \mathbf{v} = [3 \ -1 \ 4], \quad \mathbf{w} = [1 \ 2 \ 4].$$

a) Which of the following vectors are orthogonal to each other?

b) Determine a vector orthogonal (perpendicular) to both  $\mathbf{u}$  and  $\mathbf{w}$ .2.0 If  $\mathbf{x} = [0 \ -1 \ 0 \ 1]$  and  $\mathbf{y} = [1 \ 1 \ 1 \ -1]$ . Find the the angle between the vectors.3.0 Given a plane in 3-D space:  $2x - 4y + 4z + 6 = 0$ . Find the distance from the point with coordinates of  $P = (1 \ 1 \ 2)$  to the plane by using homogeneous coordinates.

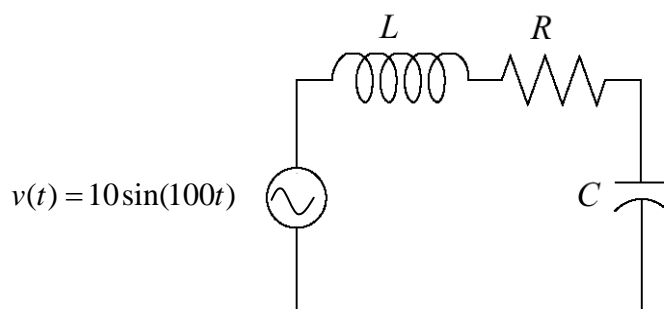
**QUESTION #3****MARKS: 15 (10+5)**

1. Express the following expressions in the form of  $a+bi$  **AND**  $r = e^{i\phi}$

a)  $\frac{(1+3i)^2}{2(1+2i)}$

b)  $(1-i)^7$

2. Consider the following circuit where  $L = 0.01$  Henries,  $R = 9$  ohms, and  $C = 0.001$  Farads. Determine the total impedance of the circuit and then express it in the polar form. It is known that the impedance of a resistor is equal to its resistance ( $R$ ), the impedance of a capacitor is equal to  $\frac{1}{\omega Cj}$ , and the impedance of an inductor is equal to  $\omega Lj$ .



QUESTION #4

MARKS: 10 (10+5)

1. Add the following two binary numbers and express the answer in binary, hexadecimal and decimal format.

10011010

+ 00111111

binary = \_\_\_\_\_

hexadecimal = \_\_\_\_\_

decimal = \_\_\_\_\_

2. Assuming the variable **combination\_1** is currently set to a value of hexadecimal E, what is it's value at the end of the following:

ldaa combination\_1

adda #\$4

anda #%00001111

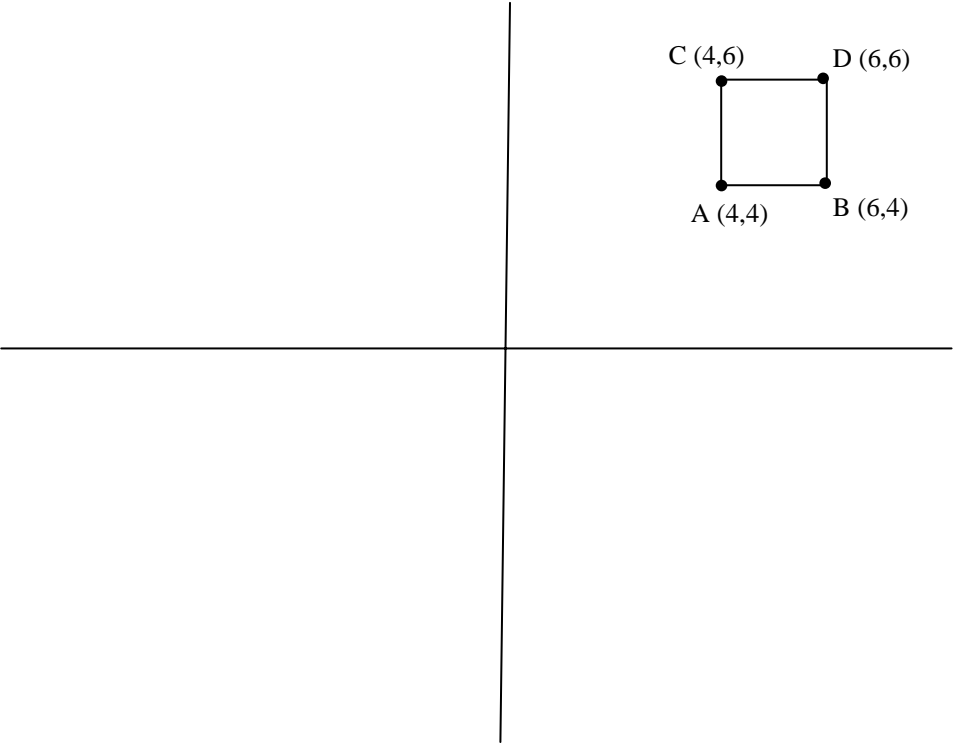
staa combination\_1

QUESTION #5

MARKS: 15 (5+5+5)

The shape given in the drawing below is to be scaled by 0.5 in the “x” direction and 2 in the “y” direction AND THEN rotated about the new corner, point **A'**, by an angle of  $\frac{\pi}{2}$  radians.

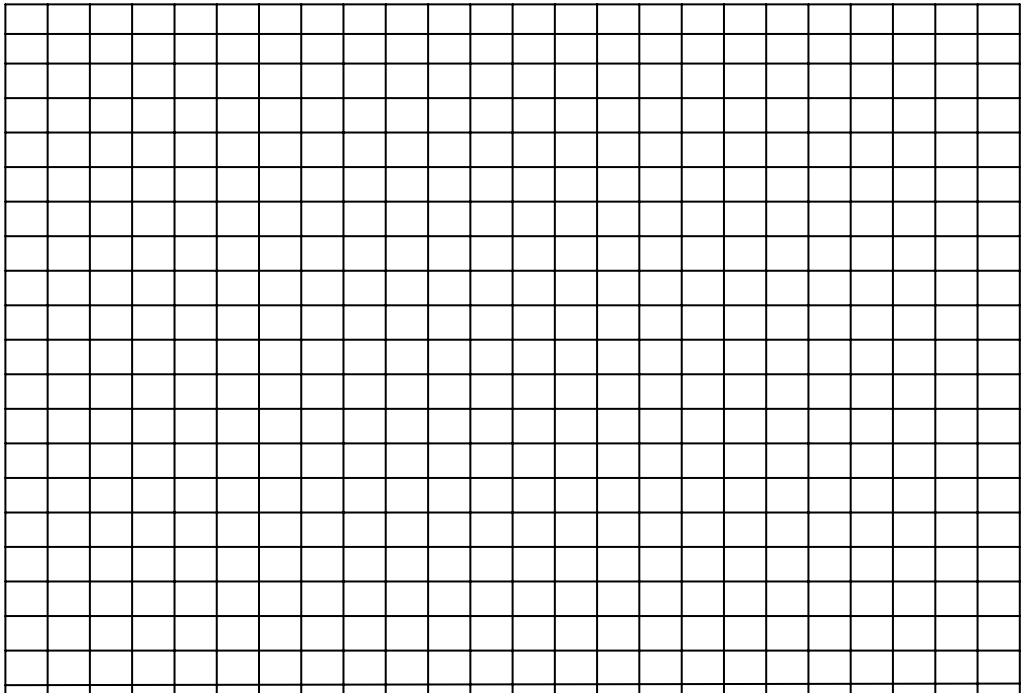
- a) Show the transformation matrix to scale the object and determine the new coordinates of the corners.
- b) Determine the concatenated transformation matrix to rotate the new shape about the new point **A'** and determine the new coordinate of each corner of the shape.
- c) Sketch your results from a) and b).



QUESTION #6

MARKS: 15 (2+3+2+3+5)

- An electrical utility is considering a new rate structure. Currently, they charge a flat rate of \$0.10 per kilowatt-hour of energy sold, but they are evaluating a variable rate structure to encourage more consumption at times of the day when usage is normally low, and lesser consumption when demand is high. This is expected to reduce their generation costs since they should need fewer generators to meet the peak load.
- Under the present flat rate structure, they measure the total power (rate of change of energy) every two hours and record the results for a complete 24 hour period of one day, starting at midnight. The measured values, in GW (GigaWatts), are as follows (note:1 GW = 1000 kW):
- 1.0, 0.8, 0.7, 1.0, 1.4, 1.6, 1.8, 1.8, 1.8, 2.0, 1.8, 1.4, 1.0
- a. On the grid supplied, plot the power vs. time.
  - b. Determine the total ENERGY supplied by the utility company during one day (in kWhrs).
  - c. The utility can only bring on more generators gradually during periods of increasing demand. When in the day is the maximum rate of increase in power demand, and what is the value of that rate of increase?
  - d. How much revenue did they generate during the 24 hour period with a flat rate of \$0.10 per kW-hr? If every day was the same, what would their annual revenue be?
  - e. Now, assume the utility introduces a variable \$ rate that is directly proportional to the rate of energy consumption (GigaWatts). Assume they establish a base rate of \$0.08 per kW-hr for a power consumption of 1.0 GW, and the rate varies linearly with the power. For example, if the power doubled, the rate would double to \$0.16 per kW-hr, and if the power consumption was 75% of the base value, the rate would be 75% of the base rate. Assuming that initially the measured power was the same as given above over the period of a day, what would the utility revenue now be for one day?
    - i) What would you expect would actually happen to the power consumption plot with this variable rate in place, assuming consumers knew what the variable rate was?
    - ii) How might this information be given to consumers so that they could make good power consumption decisions?





**QUESTION #6 (work page)**